Public Safety Management Plan
Reinig Road Revetment Repair Project

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1.0. Overview

This Plan has been prepared in accordance with the King County Department of Natural Resources and Parks (DNRP) 2013 Procedures for Managing Naturally Occurring Large Wood in King County Rivers. The procedures require DNRP to prepare a public safety management plan when designing projects that are expected to or are likely to cause wood from onsite or elsewhere in the watershed to accumulate at the project site. This Plan also follows Policy PROJ-11 in the 2006 King County Flood Hazard Management Plan (and incorporated by reference in the 2013 Flood Hazard Management Plan Update and Progress Report) for the monitoring and adaptive management of projects over time to meet permit requirements or improve the effectiveness of projects.

1.1 Purpose

The purpose of this Public Safety Management Plan (PSMP) is to propose a strategy to detect and respond to circumstances or changes in conditions at the Reinig Road Revetment project site (site) that affect public safety and infrastructure. This plan will outline safety design considerations, intended post-project site conditions, inspection and maintenance protocols, and adaptive management actions. The framework for monitoring and adaptive management in this plan may be updated as necessary to address any new public safety concerns that may arise as site conditions change both before and after project construction, and also to reflect any changes in Department policies governing site management.

1.2 Organization of the Plan

This plan is organized to first provide, in Section 2, a background of the geomorphic setting and historical conditions leading up to the existing conditions, and then to demonstrate how this background information was utilized to develop assumptions for assessing future anticipated conditions. Existing land uses described in Section 3 provide the framework for the discussion of public safety hazards and risks. Section 4 describes the approach for adaptive management.

2.0. Background

The following sections describe the physical setting, pre-construction conditions, future anticipated conditions and uncertainties of the project reach, which will influence the long-term management strategy for the project site.

2.1 Project Location and Setting

The project site is located east of the City of Snoqualmie along the right (north) bank of the Snoqualmie River at approximately River Mile 43.8 and is part of the nearly half-mile-long King County flood protection facility named Reinig Road Revetment. It is situated directly across from the confluence with the South Fork Snoqualmie River, and approximately three-quarters mile downstream of the North Fork/Middle Fork Snoqualmie River confluence. SE Reinig Road runs along the top of bank adjacent to the project site. The Snoqualmie River channel forms the jurisdictional boundary between the City of Snoqualmie and unincorporated King County.

2.1.1 Hydrologic and Geomorphic Setting

The Upper Snoqualmie Valley hydrology is complex, particularly in the vicinity of the project site generally referred to as the Three Forks area. Approximately three miles downstream of the project site, Snoqualmie Falls separates the upper valley from the lower valley.

The Three Forks area is hydraulically and geomorphically multifaceted. Each tributary of the Snoqualmie River joins together within a mile. The surrounding floodplain stretches more than a mile across, including numerous historic channel scars that crisscross the valley, indicating the historic range and complexity of these rivers. There is also a measurable backwater effect from the bedrock constriction and the hydroelectric diversion weir at Snoqualmie Falls.

Both the North Fork Snoqualmie River and Middle Fork Snoqualmie River are transitioning from steeper, naturally constrained channels in narrow mountain valleys to lower gradient channels situated in this broader floodplain near North Bend and Snoqualmie. This transition results in significant deposition of alluvium and corresponding adjustment of channel shape and alignment. Large quantities of large wood transported from upstream and recruited from local bank and floodplain erosion add additional complexity to the river channel in the project vicinity.

The project site is located on the bed and bank of an alluvial river channel and is situated at the toe of a mapped landslide. The bed of the river channel is primarily composed of alluvial deposits including unconsolidated cobbles, gravels, sands, and silt. The lower riverbank is a combination of surficial river alluvium and landslide and/or glacial deposits composed of gravel and cobble in a dense matrix of sandy silt. The upper bank soils consist of low-plasticity loose silty fine sand/sandy silt with scattered gravel. Within the road shoulder, up to 10 feet of loose to medium dense sandy silt was likely placed as fill material.

The alluvial deposits on the river bed are mobile as they are subject to natural river processes including erosion, transport and deposition. While the riverbank has been protected from river erosion since the 1960s with rock riprap revetment, sections of the riverbank where the revetment has been damaged are subject to river erosion and scour. Soils mapping and field assessment indicates the adjacent hillslope has been subject to landslides.

2.1.2 Features in Reach

This river reach is highly dynamic and rapidly evolving, resulting in significant changes to the channel shape including significantly increasing width, shifting gravel bars and primary flow

paths, and large, varying quantities and configurations of naturally recruited large wood. An examination of historic aerial photos (1942-2017), historic and modern maps and LiDAR imagery provide strong evidence that this area of the upper Snoqualmie River valley has a long history of ongoing river channel changes. While the infrastructure and utilities along the north bank of the river are protected by the Reinig Road Revetment, the left bank and adjacent floodplain is undeveloped, in a natural condition and subject to natural river processes. Due to these rapidly changing channel conditions and a lack of constructed protections, the left bank of the river is actively retreating into the adjacent floodplain forest of large cottonwood and big-leaf maple trees. Consequently, many of these large trees have and continue to fall into the river channel adjacent to and upstream of the project site.

By 2013, lateral channel migration and expansion at the downstream end of the left bank had occurred. The channel expansion and extensive left bank erosion resulted in substantial recruitment of logs and large wood and other woody material to the channel. Using the 2015 aerial photograph, a tally of large wood, many with intact root wads, found 89 pieces present in the channel between the North Fork/Middle Fork confluence and the left meander bend across from the Reinig Road revetment (see Figure 1). Left lateral channel migration and floodplain erosion have continued since 2015, recruiting additional wood into the active channel as well as trapping entrained wood that is floating downstream.

Figure 1. Looking downstream at accumulated large woody material in the Snoqualmie River at the confluence with the South Fork Snoqualmie River in 2015. Reinig Road can be seen on the right.

2.2 Project Background

2.2.1 Pre-construction Conditions

The Reinig Road revetment is a 2,795 foot long rock riprap facility that was constructed in 1966 in the wake of the 1959 flood—generally considered to be the flood of record in the Upper Snoqualmie Basin—to protect SE Reinig Road from river erosion and channel migration. Geomorphic change and ongoing erosion have severely damaged four sections of the

revetment totaling approximately 390 feet in length along an approximately 740-foot stretch of the revetment.

The revetment is located within a geomorphically complex and rapidly evolving river reach. During high flow events, high velocities and turbulence directed at the riverbank have undermined and stripped away riprap from the existing revetment, exposing the underlying riverbank material. These damages compromise the revetment's integrity, leaving it vulnerable to additional damage and increased riverbank instability. If left unaddressed, the riverbank could continue to retreat, collapse, and threaten the otherwise protected infrastructure.

An abundance of natural large woody material is present in the active channel and floodplain of the Three Forks reach of the Snoqualmie River, including fully intact and mature black cottonwood, bigleaf maple and Douglas-fir trees. Some wood is trapped in wood jams and sediment bars within the river that become re-engaged during high-flow events of sufficient magnitude and duration to initiate sediment transport. Consequently, downstream properties and infrastructure are already subjected to substantial quantities of logs and large woody material conveyed by the river during high flow events.

2.2.2 Project Goals and Objectives

The goal of the project is to repair damages to the Reinig Road revetment in order to continue providing flood protection to King County's Reinig Road, private properties, Puget Sound Energy's power transmission lines, and the City of Snoqualmie's Canyon Springs water main. Project objectives and considerations also include enhancement of aquatic and riparian habitat where possible.

2.3 Post-Construction Conditions

2.3.1 Post-Construction Project Features

The project consists of the following primary elements:

- Rock Riprap Revetment
- Vegetated Geogrids
- Native Vegetation Plantings
- Engineered Log Jams (ELJs)
- Culvert Outfalls

2.3.2 Anticipated Post-construction Conditions

The ELJs will redirect high river velocities and the deepest part of the river channel away from the right bank revetment toward the center of the river channel. Their design will accommodate changing channel hydraulics and channel geometry in this highly dynamic area. Additionally, they are designed to overtop at flows exceeding the ordinary high water elevation. The placed wood will provide several ecological functions such as increasing the structural complexity of riverine habitat. The wood structures will also promote scour pool creation, gravel sorting and areas of reduced flow velocity. Lastly, the structures will increase shading and refuge for wildlife and fish.

Current patterns and magnitudes of large wood recruitment, mobility and accumulation are not expected to measurably change as a result of the project. As previously described, the project site is located within a very dynamic reach of the river with existing, very high volumes of sediment and large wood transport and active retreat of the left bank into a forested floodplain.

Consistent with existing conditions, natural large wood from both adjacent and upstream sources may accumulate periodically at the site during high flows, including on or between the flow deflector structures. It is anticipated that large wood from natural sources will be recruited in the reach. Some wood will be transported downstream during subsequent high flow events and some will rack up on the ELJs and reside on the logjams for a period of time or semi-permanently. Wood remaining on the ELJs will be monitored and managed as described in Section 4 below.

The sizes and total quantity of the salvage trees, racking and slash materials that will be used in the Reinig Project are very small relative to the quantity of naturally available and recruited materials conveyed by the river past the site during high flow events. There is very low likelihood of significant impacts to downstream properties and structures resulting from transported logs and woody material, whether from the project site or naturally recruited. The closest bridge, the Snoqualmie Valley Trail trestle, is over a mile downstream and is able to convey significant wood and debris because it does not have mid-channel bridge piers and the low chord of the bridge deck is well above the level of the adjacent floodplain. The two other downstream bridges before Snoqualmie Falls—Meadowbrook (1.5 miles downstream) and Railroad Avenue (over 3 miles downstream)—likewise don't have mid-channel bridge piers and their low chords are above the adjacent floodplain.

2.3.3 Uncertainties

Large wood is primarily mobilized and transported downriver during high flow events. Low depths and velocities during lower and moderate flow events are typically insufficient to mobilize and transport large wood. During flood events, the Reinig ELJ's will be overtopped by more than 10 feet of water. In these conditions, large wood floating on the surface would most likely pass well above the ELJ's and be transported downstream. Given this, wood accumulation at the ELJs is expected to be temporary.

3.0. Hazard and Risk Assessment

3.1 Existing Public Uses in Vicinity of Project Site

The preconstruction land uses and potentially affected infrastructure in the vicinity of the project site are described below.

3.1.1 In-Water Recreation

Recreational use of the project site consists primarily of the general public site-seeing, bird-watching, fishing, and general river access. Water-based access (rafting, tubing, swimming, wading, etc.) at and through the project site appears to be uncommon. However, it is more common to see localized recreational use of the gravel bars and side-channels upstream of the project site during summer low-flow periods. There are significant quantities and continuously changing accumulations of naturally recruited large wood in the river channel adjacent and immediately upstream of the project site. These large wood accumulations create potentially hazardous conditions for in-water or in-channel recreational activities.

King County performed a recreation study in 2013 that covered most of the County's rivers including the upper Snoqualmie. Results indicate fewer than two percent of all floaters observed in the Snoqualmie River system were observed in the combination of the mainstem above Snoqualmie Falls, the Middle Fork Snoqualmie River, the North Fork Snoqualmie River and the South Fork Snoqualmie River. The mainstem Snoqualmie River (above the Falls) recorded an average of 3.4 people per day and fewer than two groups per day during the study period in the reach from the Falls to the upper end of Three Forks Park. The majority of recreational users on the Snoqualmie River during the study were observed in the area below Snoqualmie Falls.

3.1.2 Land Use

The surrounding properties in the general vicinity of the project site are predominantly low density rural residential parcels with a mix of pasture and forest. The project site is situated on parcels owned by King County Parks which are part of the Three Forks Natural area. On the shoulder of Reinig Road adjacent to the project site there is an informal vehicle pullout area that supports passive recreation. A steep, informal user-created footpath down the riverbank provides access to the right bank of the Snoqualmie River. The vehicle pullout also serves as a destination for the City of North Bend based Twin Peaks Tour. The pullout is a popular stop for visitors on the tour to take pictures of Mt. Si, enjoy scenery and access the river during summer low flow.

3.1.3 Roads

The only significant road in the vicinity of the project is King County's SE Reinig Road, which is of critical importance for local access and utility corridor.

3.1.4 Utilities

The primary utilities in the vicinity of the project are within the Reinig Road right-of-way and include Puget Sound Energy overhead power lines and the City of Snoqualmie buried water supply pipeline.

3.2 Public Safety Risk Analysis and Design Response

3.2.1 Public Outreach

Project information about large wood placement follows the County's communication protocol. This includes sharing project information on the DNRP Large Wood project website and outreach through the Large Wood public meetings. Public comment is available through the website and at the meetings.

Prior to project construction, King County will initiate public outreach to alert river recreational users, the general public, and the local jurisdictions to the construction periods and the potential for changing river conditions once the project is substantially completed. The County will update the project's website, mail flyers to adjacent residents and maintain communications with the local jurisdictions and river recreational groups.

There will also be signage alerting the public to potential large wood hazards. Signage will be placed upstream of the project site for in-river recreationists, allowing for opportunity to exit the river. Signs will also be placed in the parking area adjacent to the project site.

3.2.2 In-Water Recreation

The primary risk to in-water recreationalists is entrapment and drowning amid fallen trees and other natural large wood in the river. However, at the project site, flow velocities are low and flow depths relatively shallow during the summer when most of the recreational use occurs.

Though expected recreational use in the project reach is low, the design will include "bumper logs" on the upstream-most ELJ deflector structure to minimize the risk of entrapment should water-based recreationalists encounter the structure. The bumper logs consist of two logs cinched together in parallel that are attached horizontally to the upstream-most ELJ's upstream face. The height and position of the bumper logs spans the recreational minimum and maximum recreational flow levels. Therefore, swimmers or floaters that approach the ELJ from the water will encounter the bumper logs rather than the ELJ itself, and flows will carry them along the bumper logs toward open water at the river center.

The relatively dense construction of the ELJs reduces flow velocities through the structures, and thus reduces "straining" risk to recreational river users.

Additional measures include placing signs at established recreational entry points. Yellow caution signs will be attached to the upper ELJs, and signs will be placed about 1,500 feet upstream of the first ELJ, cautioning river recreationalists of potentially hazardous conditions.

3.2.3 Land Use

Access to the river from the right bank is on an informal, user-created footpath, which could potentially create a risk of injury to recreationalists due to its steep and often slippery nature. Additionally, access from this bank may increase risk that the public would climb on the constructed ELJs. The upper bank slope will be regraded and planted with dense vegetation between the Right of Way and the slope, eliminating the previously user established path and discouraging access to the ELJs. Signage will be also be placed at the top of the river bank and on the upstream ELJ by the County to warn the public.

3.2.4 Roads

The project is designed to reduce the risk of damage and temporary closures to SE Reinig Road caused by flooding.

3.2.5 Utilities

Similar to the risk reduction for SE Reinig Road, the project would reduce risk to the utilities along Reinig Road.

3.3 King County Procedures for Placing Large Wood in Rivers

King County Public Rule LUD 12-1 adopted on March 31, 2010 (Appendix B to this Plan) establishes procedures for the consideration of public safety when placing large wood in King County rivers. The procedures apply to all King County DNRP projects involving the placement of large wood in King County rivers and streams.

Section V, Part 4 of Appendix A of the Public Rule includes requirements for post-construction monitoring and the adaptive management of projects involving the placement of large wood to assess whether any new actions at the project site are warranted. Such actions may include outreach to advise the public of potential risks posed by placed large wood, placing warning signs at the site, notifying the local jurisdiction that may impose use restrictions, and removing or altering the position of placed wood to further reduce risks.

3.4 King County Procedures for Responding to Naturally Occurring Large Wood

DNRP's 2013 Procedures for Managing Naturally Occurring Large Wood in King County Rivers applies to locations within unincorporated King County, like the project site.

4.0. Monitoring and Adaptive Management Strategy

4.1 Roles and Responsibilities

As part of routine site management, existing flood monitoring programs, and broader public safety and emergency management services, King County will conduct regular observations and monitoring at the project site. These activities will consider site conditions that could potentially impact public safety or public or private property and infrastructure and will aim to identify appropriate remedial actions when necessary. The roles and responsibilities are summarized below in Table 1.

Table 1. Public Safety Roles and Responsibilities

Jurisdiction or Agency	Roles	Responsibilities
King County River and Floodplain Management Section (King County) as the primary service provider to the King County Flood Control District	Manage the Reinig Road Revetment project site.	Monitor, inspect, and maintain the integrity and function of the project components. Coordinate with local jurisdictions to address public safety.
King County Flood Control District	Provide funding for capital improvement projects, ongoing site management, and facility maintenance for purposes of flood risk reduction.	Reduce flood risks to people and property in King County.
King County Sheriff's Office	Provide expertise in the assessment of risks to river recreational users and swift water rescue.	If requested, provide technical support to local jurisdictions for the assessment of hazards to river recreational users.

As the project proponent, King County will serve as the lead agency for the management, monitoring and inspection of the various elements comprising the Reinig Road Revetment. King County will play an active role in the assessment of hazards that present a risk to the function and integrity of the facility and will provide input and assistance to the various jurisdictions and agencies to address hazardous conditions that may pose a risk to public safety and river recreational users.

4.1.1 Response Levels

The time needed to evaluate and implement adaptive management measures will vary depending on the complexity and immediacy of the problem or hazard. Immediate action may be needed to address a failing bridge pier, for example, but is not likely needed to remove a potential hazard tree that falls into the river in December. Addressing concerns posed by wood hazards may prove the most challenging and may require weeks to months to implement. Instream wood is typically modified in the summer and with prior approval from local and state regulatory agencies. Wood hazards are to be managed according to the King County policies in effect at that time.

Where signage is a sufficient response, it should be deployed in highly-visible locations, maintained, and removed once the hazard is abated. Signs will be placed and regularly monitored by County staff and replacement of the warning signs will occur if signs are damaged or lost. Public outreach should target river users most likely to encounter the hazard. Improvements at access and egress points should be coupled with warning and notification signs. River closure can also be implemented by the King County Sheriff Office.

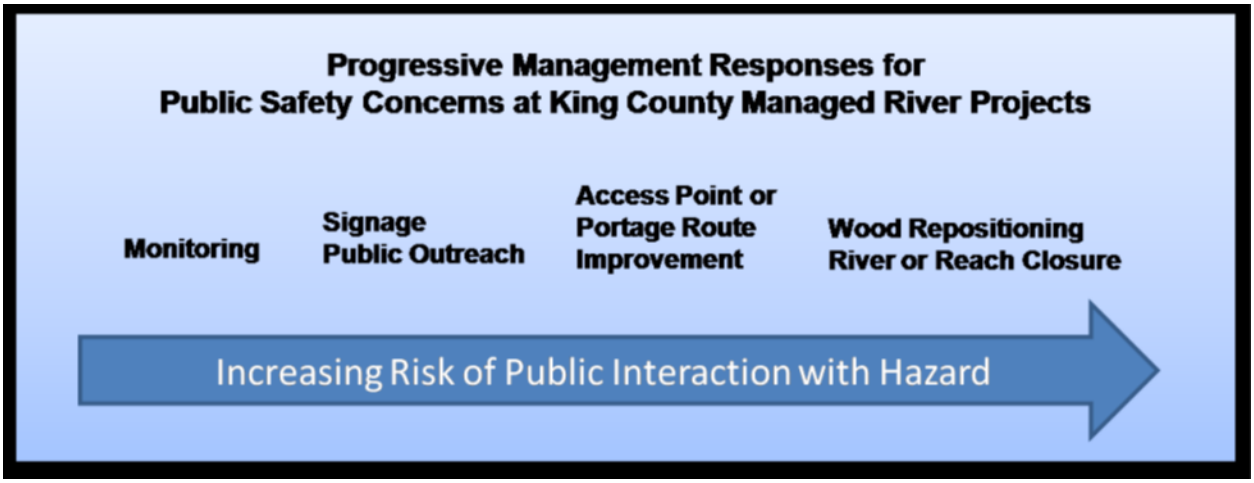

Figure 2. Progressive Management Responses for Public Safety Concerns at King County Managed River Projects.

4.2 Emergency Response

In the event of a flood emergency, the King County flood patrols and project technical leads would report observations to the Flood Warning Center. If the Flood Warning Center is not open, observations would be reported directly to the King County Office of Emergency Management. Depending on the emergency, County staff may also contact the cities, regional fire districts, and the U.S. Army Corps of Engineers Emergency Management and Water Management. In accordance with Policy ER-3 in the 2006 King County Flood Hazard Management Plan (and incorporated by reference in the 2013 Flood Hazard Management Plan Update and Progress Report), King County should consider long-term objectives for risk reduction and habitat restoration when implementing emergency response actions.

4.3 Monitoring, Inspection and Maintenance

The monitoring, inspection and maintenance of the Reinig Road facility will occur in accordance with the Site Management Plan, which includes this PSMP. The Site Management Plan specifies overarching goals and uses of the project site and the inspection, monitoring, and maintenance protocols for the flood-protection components of the facility as documented in the PSMP. The Site Management Plan will be updated periodically to reflect changes in site conditions and site management needs and strategies. The Site Management Plan will include protocols for the monitoring and reporting of river recreational hazards related to large wood.

4.3.1 Monitoring

The flood hazard conditions to be monitored include the stability of the structural elements (revetment and engineered log structures). The County will also monitor site conditions that might pose a risk to infrastructure and recreation safety. The County will monitor the locations and conditions of large wood placed as part of the project and naturally occurring large wood accumulating within the project reach. Monitoring will be conducted during and after large flood events to characterize changing patterns in wood loading and to evaluate the risks that accumulations of large wood might pose to recreational users, the facility, and other infrastructure and public safety. Observations that may pose risk to recreational users will be posted on the County's website of known hazards in King County rivers. Monitoring and reporting protocols will be modified as needed to address changing conditions.

4.3.2 Facility Inspection

The Reinig Road Revetment facility will be inspected at least every other year during summer, low-flow conditions (when most of the facility is visible) and immediately after major flood events consistent with King County DNRP river facility inspection protocols. As part of the flood emergency response protocols, King County dispatches flood patrols to inspect levees after an earthquake with a moment magnitude greater than 5.5 in the Puget Sound area. The routine and post-flood inspections will document conditions using the standard King County facility inspection form and digital photographs. The inspections will identify and characterize the location, nature, and severity of any damage and note any follow-up assessments needed by an engineer, geologist, ecologist, or maintenance specialist.

King County will use the information obtained from the periodic monitoring and inspections to perform preliminary assessments of potential hazards and risks to public safety.

4.4 Adaptive Management Strategies

The findings from the monitoring and inspections will determine the need for adaptive management actions at the project site. The County will consider a range of adaptive management actions to address site conditions that may pose a risk to public safety, threaten the structural integrity of the flood facility, or indicate habitat parameters that do not meet the performance standards for project effectiveness required by the federal and state permits. Alternatives for adaptive management actions will be developed in collaboration with regulatory agencies, tribal representatives, and river recreation groups such as the River Safety Council. Any actions taken by the County will be in accordance with all regulatory requirements, King County Public Rules and DNRP policies, procedures, and guidelines for the management and maintenance of flood facilities and in-stream projects.

4.4.1 Revetments

Damage that has already occurred or that appears imminent to any segment of the Reinig Road Revetment would be addressed on a case-by-case basis by King County in coordination with the local jurisdictions, regulatory agencies, tribal representatives and adjacent property owners. The main goals of any adaptive management action would be aimed at protecting public safety and minimizing future maintenance costs of the facility.

5.0. References

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